5.7 Soils, Geology, and Groundwater

The Renton Nickel Improvement Project will be constructed in a highly variable geologic area that includes large liquefaction zones that can be problematic during earthquakes. The new bridges will be designed to current seismic standards and will be founded on deep piles to avoid damage from soil liquefaction during earthquakes. Although project construction will likely increase erosion, disturb moisture-sensitive soils, and produce construction-related vibration, these effects will be temporary. The project will not affect the City of Renton's water supply wells.

The geologic conditions of an area determine how bridge foundations can be constructed

WSDOT considers soils, geology, and groundwater because these are major factors in determining the types of foundations, pavement sections, subsurface drainage, retaining walls, and bridges required for the project. When we refer to soils and geology, we mean the physical material that makes up the ground. These physical characteristics also determine the risk of landslides, liquefaction, erosion, and other types of behavior, which can affect the environment.

Groundwater pertains to the water contained in the soil and bedrock below the ground's surface. We consider groundwater quality and quantity because changes to quality and quantity can affect water supplies for drinking water, and water available for surface waterbodies such as lakes, streams, and wetlands.

Please refer to the Renton Nickel Improvement Project Soils, Geology, and Groundwater Discipline Report in Appendix U for a complete discussion of the analysis for these topics.

What is the geology of the study area?

The existing topography and surface geology of the Puget Sound region are largely the result of Pleistocene glacial, Holocene river, and volcanic processes. During the last century, human activities caused large-scale landscape modifications, such as the lowering of Lake Washington in the early 1900s and widespread topographic changes associated with urbanization.

The geology of the study area consists of a variety of soil types and bedrock. These are described in the following sections.

Soils

What are engineered fills?

Engineered fill is soil that is placed and compacted according to design specifications for the construction of roads, structures, or buildings.

Engineered roadbed fill underlies I-405 and SR 167 except for where bridges have been constructed. Non-engineered fill, consisting of coal mine tailings (crushed rock and coal) and concrete blocks underlies I-405 approximately at milepost (MP) 3.1, near a tunnel associated with the abandoned Renton Coal Mine.[3] Non-engineered fill underlies much of the Cedar River Valley to the west of the study area between MP 2.8 and the northern end of the project. These fills were likely not compacted to design specifications for constructing roads.

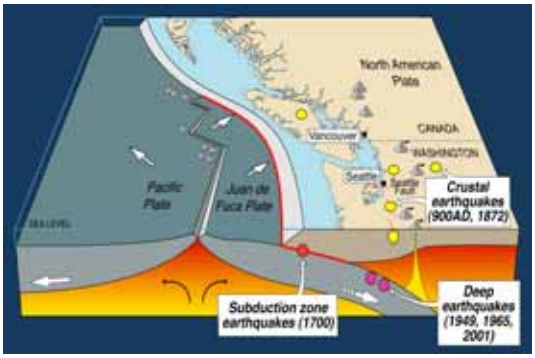
Glaciers deposited the soil underlying the areas near the I-5/I-405 interchange, south of the Benson Road Bridge over I-405, and south of the Cedar River. These deposits near the I-5/I-405 interchange consist of glacial till, an unsorted, crudely-stratified mix of very dense silt, sand, gravel, and cobbles. The most common surface material in the study area is alluvium, which is sediment deposited by flowing water. Recessional outwash, sediment deposited by flowing water from a glacier, underlies the study area near Benson Road and south of the Cedar River. This sediment generally consists of stratified sand, interbedded with thin silt layers, and scattered gravel-rich layers.

What are sandstone, siltstone, and coal?

Sandstone and siltstone are sedimentary rocks composed of sand and silt-sized particles that have become compressed and cemented until they form a rock. Coal is formed from peat that has been compressed and heated.

Renton Formation bedrock underlies the study area between the I-405 interchanges with I-5 and SR 181 as well as between the SR 167 interchange and the Cedar River. The Renton Formation generally consists of weathered sandstone with siltstone and coal interbeds and scattered conglomerate (i.e., gravel-rich sandstone) layers. Near the SR 181 interchange, the sandstone is intruded by basalt.

Earthquake activity



Pacific Northwest tectonic setting. Source: Troost 2003.

The study area is in a region of active tectonics where earthquakes occur because of the interaction of tectonic plates. These plates, pieces of the Earth's crust, move independently of each other. Offshore of Washington, Oregon, and British Columbia, the Juan de Fuca oceanic crustal plate is moving northeastward toward, and converging with the North American

[3] Walsh and Bailey, 1989. Coal Mine Subsidence at Renton, Washington, in Galster, R.W, Coombs, H.A., Bliton, W.S., Neff, G.E., McCrumb, D.R., Laprade, W.T., Evans, W.D., Jr., Robinson, R.A., Koler, T.E., Warfel, M.R., West, L., Bailey, J.S., Marcus, K.L., and Schuster, R.L., eds., Engineering Geology in Washington, Volumes I and II. Washington Division of Geology and Earth Resources, Bulletin 78, p. 703-712.

continental crustal plate.[4] The study area is on the North American plate.

Strong seismic ground shaking can be made more damaging to structures by the effects of deep, soft ground. Soft ground can act like a "bowl of jello" increasing ground acceleration and movement at the surface. Most of the study area is underlain by soft soils that have the potential to liquefy during an earthquake. Exhibit 5-17 shows where the project has the highest liquefaction potential. Other geologic units underlying the study area, such as till, bedrock, or organic soils have a much lower potential to liquefy.

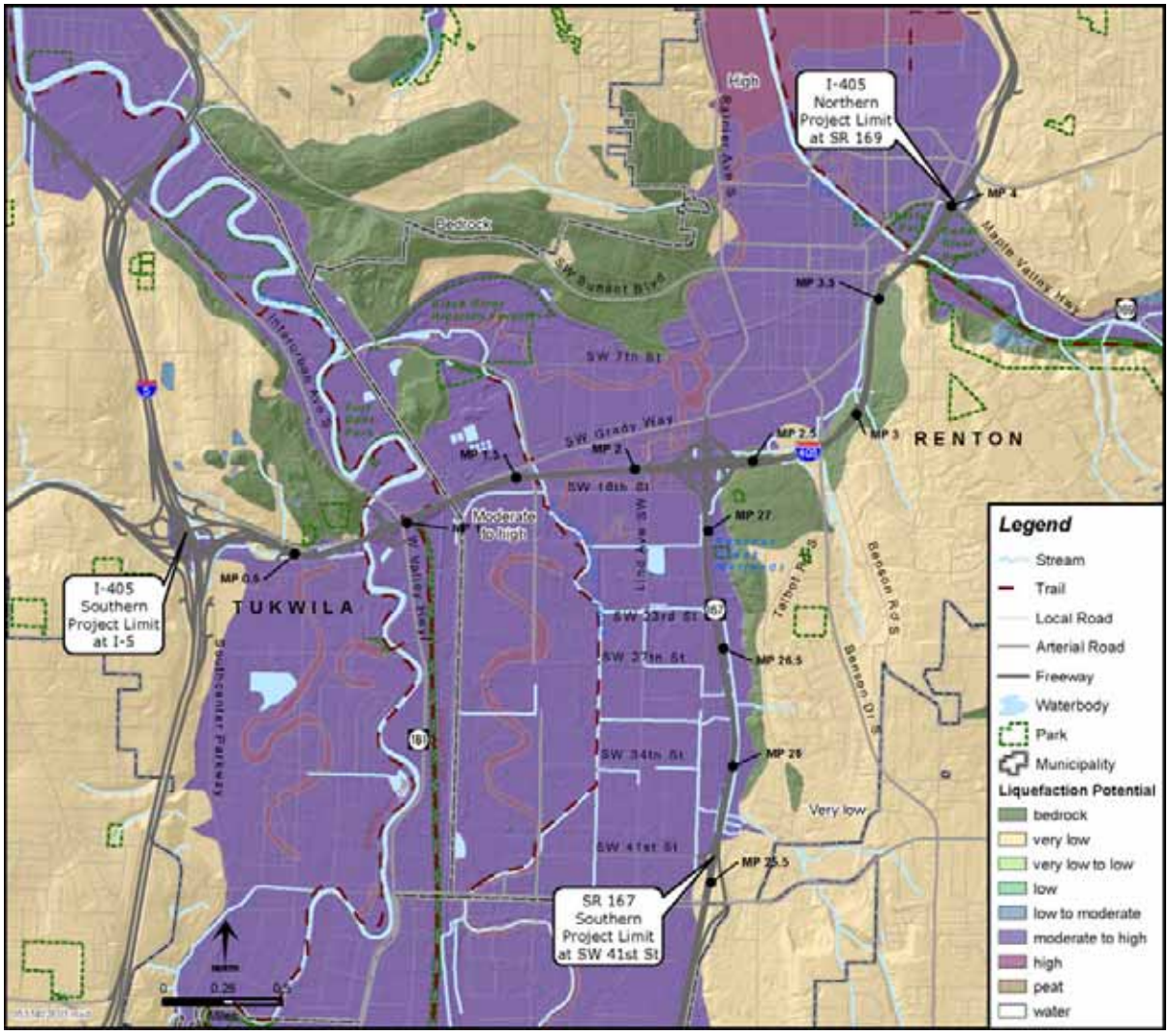


Exhibit 5-17. Liquefaction Potential in the Study Area.
Source: Palmer et al. 2004

[4] Yeats et al., 1997, The Geology of Earthquakes.

What is an aquifer?

An aquifer is an area of saturated geologic materials that are capable of producing useable quantities of groundwater on a long-term, sustainable basis.

What are Sole-Source Aquifers?

Sole Source Aquifers are U.S. EPA-designated aquifers where few or no reasonable alternatives exist for acquiring drinking water.

What are groundwater resources in the study area?

The most important aquifer in the study area exists along the Cedar River, known as the Cedar Valley Aquifer. The Cedar Valley Aquifer is an EPA-designated "Sole-Source Aquifer." This aquifer has been subdivided into several smaller aquifer subunits. The Delta Aquifer subunit is located along the lower drainage of the Cedar River and is the closest to the I-405 project as shown in Exhibit 5-18. The Delta Aquifer is unconfined and composed of alluvial sediments deposited by the lower Cedar River.

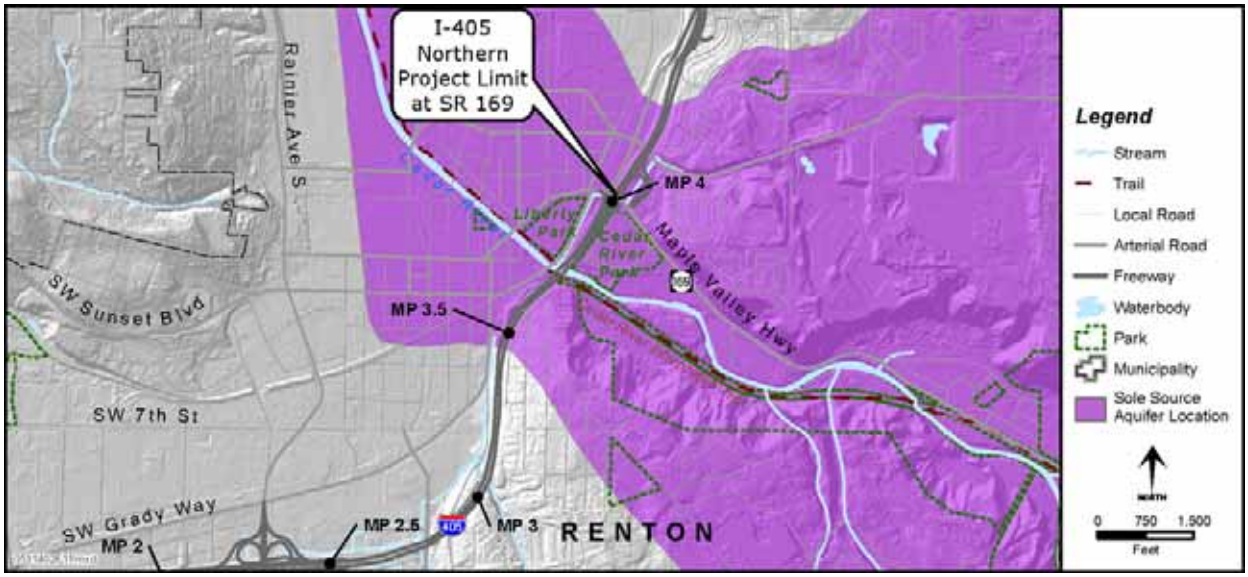


Exhibit 5-18. Boundaries of the Cedar Valley Sole-Source Aquifer in the vicinity of the Study Area
Sources: City of Renton, 2003 and Federal Register, October 3, 1988

The Delta Aquifer portion of the designated Sole-Source Cedar Valley Aquifer produces good quality water for potable use. The groundwater meets all Washington State Department of Health water quality criteria.

The City of Renton uses this aquifer for drinking water and therefore has established Aquifer Protection Zones for the Sole-Source Cedar Valley Aquifer and its production well fields. To protect its sole-source aquifer, the Renton Municipal Code specifies construction requirements for stormwater facilities and pipelines, sewer pipelines, storage limitations for hazardous/toxic substances and other requirements for activities within the aquifer protection zones.

The Green-Duwamish River Valley Aquifer is also in the study area and is an unconfined aquifer system.

Groundwater is shallow in this aquifer, often less than 10 feet below ground surface, but varies considerably with surface topography and season. Groundwater flow in the Green-Duwamish River Valley Aquifer is complex. The presence of wetlands and drainage ditches locally influences groundwater flow patterns. Most of the groundwater discharges to the Green-Duwamish River, but some groundwater may also discharge to the Delta Aquifer and Lake Washington.

The presence of shallow groundwater can require additional construction measures, such as dewatering trenches that will be dug for utilities and highway excavation. It can be reasonably expected that excavations will encounter shallow groundwater between the SR 181 interchange and the SR 167 interchange on I-405 and between the I-405 interchange and SW 41st Street on SR 167. Areas that have been previously filled, such as those where previous construction of I-405 or nearby buildings has taken place, may have a deeper water table depending on the thickness of the fill.

How will project construction affect soils, geology, and groundwater?

Liquefaction-prone soils

The new northbound and southbound I-405 bridges over Springbrook Creek will be designed to current seismic standards, which may include supporting the bridges on new deep pile foundations. The soil under the bridge approaches may need to be improved to minimize the risk of seismically induced liquefaction.

What is liquefaction?

Liquefaction usually occurs in saturated, loose, granular soil such as sand, silty sand, and sandy silt. During a strong earthquake, these soils lose their grain-to-grain contact and essentially become slurry with characteristics like quicksand.

Moisture-sensitive soils

Most of the soils that will be encountered during construction are moisture sensitive. These soils include alluvium, till, weathered bedrock, and existing embankment fills.

Heavy earthmoving equipment tracking on moisture-sensitive soils during wet weather, in areas of seepage, or in areas of shallow groundwater will tend to degrade the subgrade into a soft, unstable material. WSDOT and the local earthmoving contractors are aware of these types of conditions and routinely use a variety of methods to minimize adverse effects.

What do you mean by subgrade?

The subgrade is the in-place material on which the pavement or embankment fills are placed.

Erosion

Most soil types in the study area are susceptible to erosion. Erosion potential also increases when:

- Hillsides are cut creating a steep, bare slope.
- Fill is placed to widen existing embankments.
- Fill material is stockpiled prior to being placed during construction.

Erosion will be minimized, but not completely eliminated, through the standard implementation of BMPs that are designed to control erosion.

Groundwater

Construction will not take place over the sole-source aquifer recharge area, therefore the Renton Nickel Improvement Project will not affect the City of Renton's supply wells.

How will the completed project affect soils, geology, and groundwater?

Once construction is complete and the highway is in use there will be no effect to soils, geology, and groundwater. The conditions along the alignment are not unusual for the Puget Sound area and are routinely encountered by WSDOT in their design, operation, and maintenance plans.

What measures are proposed to minimize effects on soils, geology, and groundwater during construction?

The majority of potential negative effects associated with the construction and operation of the project will be avoided or minimized through the use of BMPs and by following the procedures outlined in the WSDOT Geotechnical Design Manual and Bridge Design Manual. Contractors and consultants associated with this project will follow these procedures. A brief summary of these procedures is listed in Appendix B.